



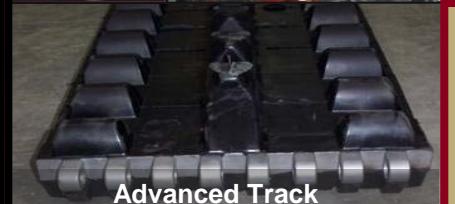
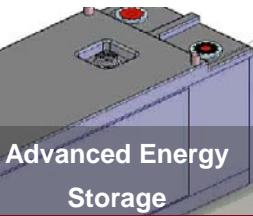
UNCLASSIFIED: Dist A. Approved for public release.



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Ground Vehicle Power & Mobility Overview for
For Japan TRDI
15 Mar 10

Report Documentation Page			Form Approved OMB No. 0704-0188	
<p>Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p>				
1. REPORT DATE 15 MAR 2010	2. REPORT TYPE N/A	3. DATES COVERED -		
4. TITLE AND SUBTITLE Ground Vehicle Power & Mobility Overview for Japan TRDI			5a. CONTRACT NUMBER	
			5b. GRANT NUMBER	
			5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)			5d. PROJECT NUMBER	
			5e. TASK NUMBER	
			5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000, USA			8. PERFORMING ORGANIZATION REPORT NUMBER 20611RC	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S) TACOM/TARDEC	
			11. SPONSOR/MONITOR'S REPORT NUMBER(S) 20611RC	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited				
13. SUPPLEMENTARY NOTES The original document contains color images.				
14. ABSTRACT				
15. SUBJECT TERMS				
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 11
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified		19a. NAME OF RESPONSIBLE PERSON

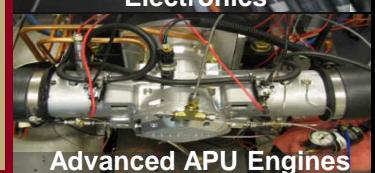


VISION:
To be the Best in the World at determining and delivering the Best Integrated Power, Energy and Mobility Solutions for the Joint Warfighters' needs; and to be the Army's recognized "focal point" for Power, Energy and Mobility Technology expertise and the GVPM Technology Systems Integrator for the current and future force ground vehicle systems.

MISSION:
To research, develop, test, validate and integrate the right Power, Energy and Mobility technology solutions to provide superior capabilities for the current and future force ground system forces.

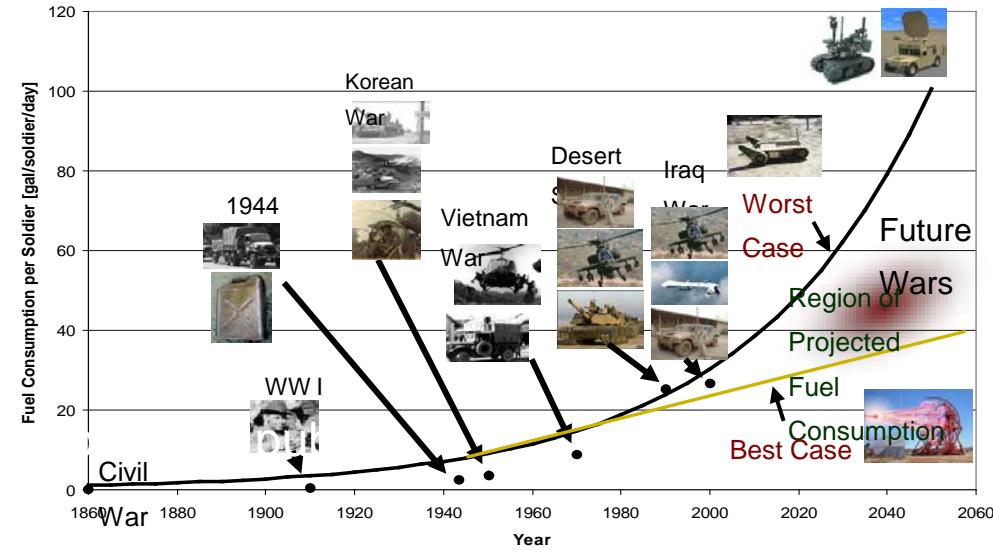


Unclassified

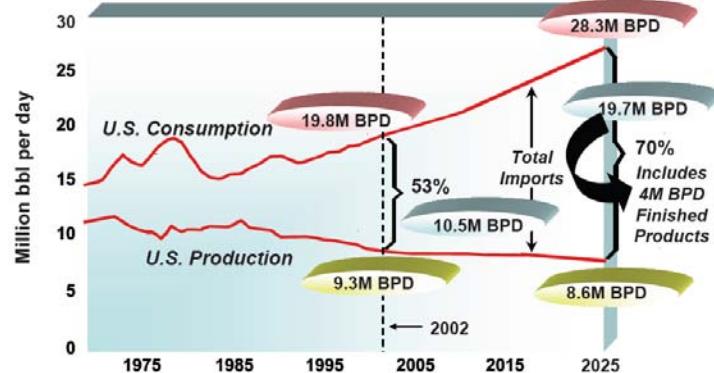


The Challenges

- Battlefield consumption of energy increasing
 - New C4ISR technologies
 - IED Defeat Systems
 - New weapons
- Energy security problematic
 - Increasing dependence on foreign oil
 - Alternative sources sought -- wind, solar, bio-mass, waste to energy
- Operational issues
 - Battery usage & limitations – energy & power density
 - Demand for auxiliary power on-board vehicles
 - Emphasis on silent (“quiet”) watch
 - Unmanned vehicles (air/ground)
 - Unattended sensors
 - Inefficient management/ distribution of power
 - Demand for soldier-wearable power
- Increased emphasis on system power metrics (KPPs, low consumption components)



The US: Our Increasing Reliance on Fossil Energy Imports



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Power Generation	Diesel Engines Rotary Engines	Transmissions	Traction Motors	Integrated Starter Generator	Turbine Engines	Alternators	Drivelines
Energy Storage	Li-ion / Ultracap Hybrid Energy Storage	Capacitors	Advanced Batteries	Advanced Batteries	Fuel Cells	Fuels	Fuels
Thermal Transport & Distribution	Radiators	Thermal Interface Materials	Heat Recovery	Phase Change Cooling	Advanced Electronics Cooling	Thermal Architectures	Thermal Architectures
Power Control & Distribution	Power Controllers for Power Management	Power Converters/Inverters	Wide Band Gap Materials (SiC)	High Temperature SiC Modules	Pulse Power Switching	High Temperature Capacitors	High Temp Inductors
Track & Suspension	Track Systems	Suspension Systems	Electronic Stability Control	Elastomer Research	Elastomer Research	Elastomer Research	Elastomer Research

- High power and temperature capable Power Electronics.
- Advanced component and system Thermal Management systems.
- Advanced component and system Power Management systems.
- Military adaptable, high power density, efficient, Diesel Engines.

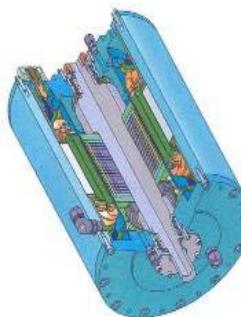


Problem:

- Hybrid electric systems for combat and tactical vehicles are challenged to meet mobility requirements within the specified space and weight constraints
- The State Of the Art power electronics operate at low temperatures resulting in a large thermal burden, increasing the power needed from the prime mover to cool the system
- These challenges result in over sizing the engine/generator to gain power lost to the cooling system

Research Challenges:

- Research high temperature / high frequency compact power electronics
- Research high power / high torque density motor / generators



Traction Motor



DC-DC Power Converter



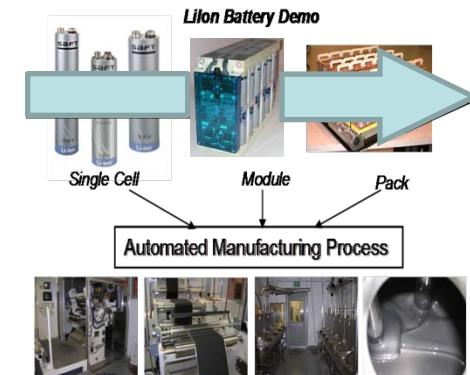
Integrated Starter Generator

Problem:

- High power battery packs sized for combat hybrid electric vehicles are too large or extremely costly.
- High power advanced batteries for combat hybrid vehicle application must be safer and more reliable.

Research Challenges:

- Research thermal runaway process and its control.
- Research power vs. energy trade-off design optimization.
- Research manufacturing process development and cost control.
- Research thermal management.
- Research cell & system, safety & reliability.
- Research system control & cell and battery management systems.
- Research alternative electrochemical improvements, including alternative chemistries and battery materials.



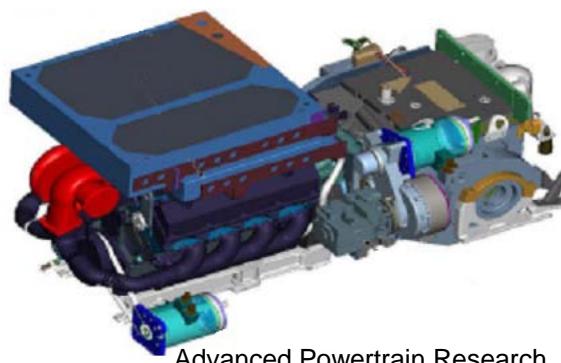
Unclassified

Problem:

- Current high power commercial engines/powertrains are not compact enough for future manned ground combat platforms.
- Future ground combat vehicles will require lighter and more efficient powertrains that occupy less space, improve vehicle mobility, reduce fuel consumption and thermal load.
- Current state of the art engines require development to operate on one fuel forward (JP-8) and meet future vehicle power and mobility needs.

Research Challenges:

- Diesel combustion research to decrease physical burn time.
- Propulsion system research to increase power density and efficiency.
- Propulsion system thermal management research.
- Research combustion optimization strategy for JP-8 military version of an emission compliant commercial. Engine control strategy for maintaining power with alternative heavy fuels.



Advanced Powertrain Research
And Development



Advanced Engine Research



Advanced Combustion
System Research

Unclassified

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Problem:

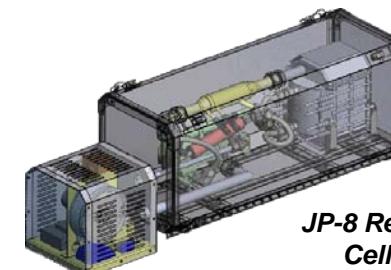
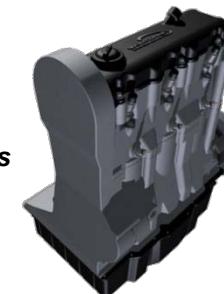
- Current non-primary power approach in field is inadequate for silent watch.
- Lead-acid batteries store insufficient energy to meet War Fighter requirements for vehicle silent watch (main engine off). Silent watch requirements vary from several hours to 24 hours. Current approach requires restarting of main engines during silent watch to recharge batteries, causing excessive fuel use, acoustic and thermal signatures.

Research Challenges:

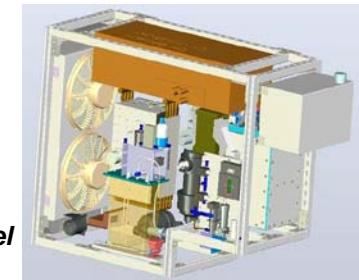
- Research engine-generator technologies with high power densities and low acoustic signatures.
- JP-8 reformation and desulfurization necessary for battlefield fuel cell application.
- Integration of fuel cells with JP-8 reformers to create APU system compatible with combat vehicle requirements
- Research fuel cell system optimization with batteries and ultra-capacitors.



Power Dense APUs



*JP-8 Reformed Fuel
Cell Systems*



Unclassified

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Problem:

- Current and future force electrical power demands exceed power generation and energy storage capabilities.
- Advanced power generation systems depend on sophisticated control methodologies for safe operation.
- Limited fuel availability in the field.
- Increasing number and size of electrical loads on a vehicular platform increases the heat generation.
- Presently, no automated way to recover from faults and induced faults (i.e. Sympathetic tripping, chain tripping of loads).
- Current vehicular electrical architectures contain vehicle-unique electrical components which increase the logistics burden.

Research Challenges:

- Research ability to accurately monitor and control the power distribution and react to fluctuating loads and sources in real time through algorithm development.
- Research common architecture approach (plug & play) for future electrical power equipment insertion.
- Research power requirements of military equipment and load management strategy.



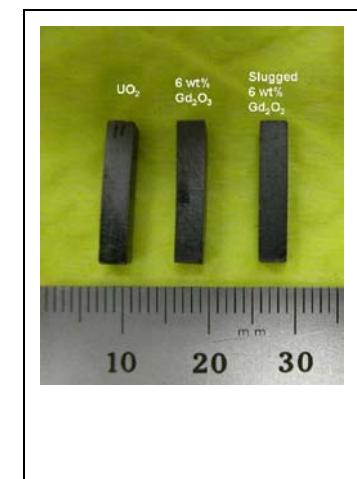
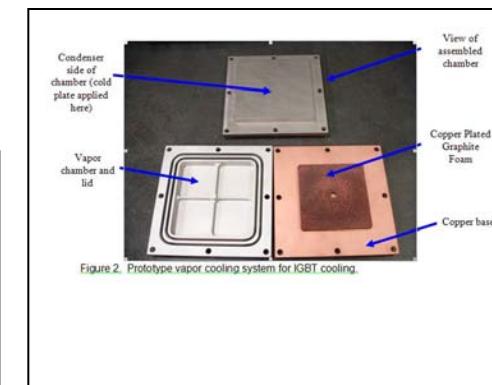
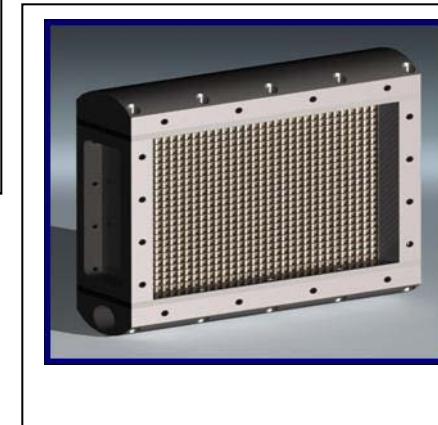
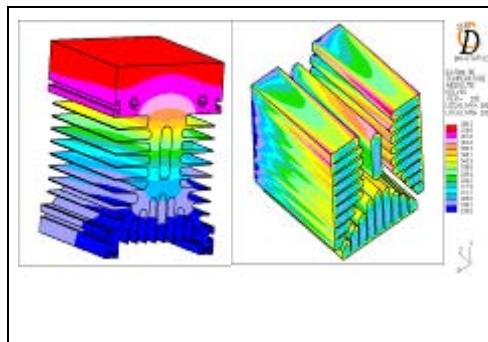
Survivability Loads			
Device Name	Voltage	Current	Power
Power Bus 1	0.00	0.00	0.00
Power Bus 2	0.00	0.00	0.00
Power Bus 3	0.00	0.00	0.00
Power Bus 4	0.00	0.00	0.00
Power Bus 5	0.00	0.00	0.00
Power Bus 6	0.00	0.00	0.00
Power Bus 7	0.00	0.00	0.00
Power Bus 8	0.00	0.00	0.00
Power Bus 9	0.00	0.00	0.00
Power Bus 10	0.00	0.00	0.00
Power Bus 11	0.00	0.00	0.00
Power Bus 12	0.00	0.00	0.00
Power Bus 13	0.00	0.00	0.00
Power Bus 14	0.00	0.00	0.00
Power Bus 15	0.00	0.00	0.00
Power Bus 16	0.00	0.00	0.00
Power Bus 17	0.00	0.00	0.00
Power Bus 18	0.00	0.00	0.00
Power Bus 19	0.00	0.00	0.00
Power Bus 20	0.00	0.00	0.00
Power Bus 21	0.00	0.00	0.00
Power Bus 22	0.00	0.00	0.00
Power Bus 23	0.00	0.00	0.00
Power Bus 24	0.00	0.00	0.00
Power Bus 25	0.00	0.00	0.00
Power Bus 26	0.00	0.00	0.00
Power Bus 27	0.00	0.00	0.00
Power Bus 28	0.00	0.00	0.00
Power Bus 29	0.00	0.00	0.00
Power Bus 30	0.00	0.00	0.00
Power Bus 31	0.00	0.00	0.00
Power Bus 32	0.00	0.00	0.00
Power Bus 33	0.00	0.00	0.00
Power Bus 34	0.00	0.00	0.00
Power Bus 35	0.00	0.00	0.00
Power Bus 36	0.00	0.00	0.00
Power Bus 37	0.00	0.00	0.00
Power Bus 38	0.00	0.00	0.00
Power Bus 39	0.00	0.00	0.00
Power Bus 40	0.00	0.00	0.00
Power Bus 41	0.00	0.00	0.00
Power Bus 42	0.00	0.00	0.00
Power Bus 43	0.00	0.00	0.00
Power Bus 44	0.00	0.00	0.00
Power Bus 45	0.00	0.00	0.00
Power Bus 46	0.00	0.00	0.00
Power Bus 47	0.00	0.00	0.00
Power Bus 48	0.00	0.00	0.00
Power Bus 49	0.00	0.00	0.00
Power Bus 50	0.00	0.00	0.00
Power Bus 51	0.00	0.00	0.00
Power Bus 52	0.00	0.00	0.00
Power Bus 53	0.00	0.00	0.00
Power Bus 54	0.00	0.00	0.00
Power Bus 55	0.00	0.00	0.00
Power Bus 56	0.00	0.00	0.00
Power Bus 57	0.00	0.00	0.00
Power Bus 58	0.00	0.00	0.00
Power Bus 59	0.00	0.00	0.00
Power Bus 60	0.00	0.00	0.00
Power Bus 61	0.00	0.00	0.00
Power Bus 62	0.00	0.00	0.00
Power Bus 63	0.00	0.00	0.00
Power Bus 64	0.00	0.00	0.00
Power Bus 65	0.00	0.00	0.00
Power Bus 66	0.00	0.00	0.00
Power Bus 67	0.00	0.00	0.00
Power Bus 68	0.00	0.00	0.00
Power Bus 69	0.00	0.00	0.00
Power Bus 70	0.00	0.00	0.00
Power Bus 71	0.00	0.00	0.00
Power Bus 72	0.00	0.00	0.00
Power Bus 73	0.00	0.00	0.00
Power Bus 74	0.00	0.00	0.00
Power Bus 75	0.00	0.00	0.00
Power Bus 76	0.00	0.00	0.00
Power Bus 77	0.00	0.00	0.00
Power Bus 78	0.00	0.00	0.00
Power Bus 79	0.00	0.00	0.00
Power Bus 80	0.00	0.00	0.00
Power Bus 81	0.00	0.00	0.00
Power Bus 82	0.00	0.00	0.00
Power Bus 83	0.00	0.00	0.00
Power Bus 84	0.00	0.00	0.00
Power Bus 85	0.00	0.00	0.00
Power Bus 86	0.00	0.00	0.00
Power Bus 87	0.00	0.00	0.00
Power Bus 88	0.00	0.00	0.00
Power Bus 89	0.00	0.00	0.00
Power Bus 90	0.00	0.00	0.00
Power Bus 91	0.00	0.00	0.00
Power Bus 92	0.00	0.00	0.00
Power Bus 93	0.00	0.00	0.00
Power Bus 94	0.00	0.00	0.00
Power Bus 95	0.00	0.00	0.00
Power Bus 96	0.00	0.00	0.00
Power Bus 97	0.00	0.00	0.00
Power Bus 98	0.00	0.00	0.00
Power Bus 99	0.00	0.00	0.00
Power Bus 100	0.00	0.00	0.00
Power Bus 101	0.00	0.00	0.00
Power Bus 102	0.00	0.00	0.00
Power Bus 103	0.00	0.00	0.00
Power Bus 104	0.00	0.00	0.00
Power Bus 105	0.00	0.00	0.00
Power Bus 106	0.00	0.00	0.00
Power Bus 107	0.00	0.00	0.00
Power Bus 108	0.00	0.00	0.00
Power Bus 109	0.00	0.00	0.00
Power Bus 110	0.00	0.00	0.00
Power Bus 111	0.00	0.00	0.00
Power Bus 112	0.00	0.00	0.00
Power Bus 113	0.00	0.00	0.00
Power Bus 114	0.00	0.00	0.00
Power Bus 115	0.00	0.00	0.00
Power Bus 116	0.00	0.00	0.00
Power Bus 117	0.00	0.00	0.00
Power Bus 118	0.00	0.00	0.00
Power Bus 119	0.00	0.00	0.00
Power Bus 120	0.00	0.00	0.00
Power Bus 121	0.00	0.00	0.00
Power Bus 122	0.00	0.00	0.00
Power Bus 123	0.00	0.00	0.00
Power Bus 124	0.00	0.00	0.00
Power Bus 125	0.00	0.00	0.00
Power Bus 126	0.00	0.00	0.00
Power Bus 127	0.00	0.00	0.00
Power Bus 128	0.00	0.00	0.00
Power Bus 129	0.00	0.00	0.00
Power Bus 130	0.00	0.00	0.00
Power Bus 131	0.00	0.00	0.00
Power Bus 132	0.00	0.00	0.00
Power Bus 133	0.00	0.00	0.00
Power Bus 134	0.00	0.00	0.00
Power Bus 135	0.00	0.00	0.00
Power Bus 136	0.00	0.00	0.00
Power Bus 137	0.00	0.00	0.00
Power Bus 138	0.00	0.00	0.00
Power Bus 139	0.00	0.00	0.00
Power Bus 140	0.00	0.00	0.00
Power Bus 141	0.00	0.00	0.00
Power Bus 142	0.00	0.00	0.00
Power Bus 143	0.00	0.00	0.00
Power Bus 144	0.00	0.00	0.00
Power Bus 145	0.00	0.00	0.00
Power Bus 146	0.00	0.00	0.00
Power Bus 147	0.00	0.00	0.00
Power Bus 148	0.00	0.00	0.00
Power Bus 149	0.00	0.00	0.00
Power Bus 150	0.00	0.00	0.00
Power Bus 151	0.00	0.00	0.00
Power Bus 152	0.00	0.00	0.00
Power Bus 153	0.00	0.00	0.00
Power Bus 154	0.00	0.00	0.00
Power Bus 155	0.00	0.00	0.00
Power Bus 156	0.00	0.00	0.00
Power Bus 157	0.00	0.00	0.00
Power Bus 158	0.00	0.00	0.00
Power Bus 159	0.00	0.00	0.00
Power Bus 160	0.00	0.00	0.00
Power Bus 161	0.00	0.00	0.00
Power Bus 162	0.00	0.00	0.00
Power Bus 163	0.00	0.00	0.00
Power Bus 164	0.00	0.00	0.00
Power Bus 165	0.00	0.00	0.00
Power Bus 166	0.00	0.00	0.00
Power Bus 167	0.00	0.00	0.00
Power Bus 168	0.00	0.00	0.00
Power Bus 169	0.00	0.00	0.00
Power Bus 170	0.00	0.00	0.00
Power Bus 171	0.00	0.00	0.00
Power Bus 172	0.00	0.00	0.00
Power Bus 173	0.00	0.00	0.00
Power Bus 174	0.00	0.00	0.00
Power Bus 175	0.00	0.00	0.00
Power Bus 176	0.00	0.00	0.00
Power Bus 177	0.00	0.00	0.00
Power Bus 178	0.00	0.00	0.00
Power Bus 179	0.00	0.00	0.00
Power Bus 180	0.00	0.00	0.00
Power Bus 181	0.00	0.00	0.00
Power Bus 182	0.00	0.00	0.00
Power Bus 183	0.00	0.00	0.00
Power Bus 184	0.00	0.00	0.00
Power Bus 185	0.00	0.00	0.00
Power Bus 186	0.00	0.00	0.00
Power Bus 187	0.00	0.00	0.00
Power Bus 188	0.00	0.00	0.00
Power Bus 189	0.00	0.00	0.00
Power Bus 190	0.00	0.00	0.00
Power Bus 191	0.00	0.00	0.00
Power Bus 192	0.00	0.00	0.00
Power Bus 193	0.00	0.00	0.00
Power Bus 194	0.00	0.00	0.00
Power Bus 195	0.00	0.00	0.00
Power Bus 196	0.00	0.00	0.00
Power Bus 197	0.00	0.00	0.00
Power Bus 198	0.00	0.00	0.00
Power Bus 199	0.00	0.00	0.00
Power Bus 200	0.00	0.00	0.00
Power Bus 201	0.00	0.00	0.00
Power Bus 202	0.00	0.00	0.00
Power Bus 203	0.00	0.00	0.00
Power Bus 204	0.00	0.00	0.00
Power Bus 205	0.00	0.00	0.00
Power Bus 206	0.00	0.00	0.00
Power Bus 207	0.00	0.00	0.00
Power Bus 208	0.00	0.00	0.00
Power Bus 209	0.00	0.00	0.00
Power Bus 210	0.00	0.00	0.00
Power Bus 211	0.00	0.00	0.00
Power Bus 212	0.00	0.00	0.00
Power Bus 213	0.00	0.00	0.00
Power Bus 214	0.00	0.00	0.00
Power Bus 215	0.00	0.00	0.00
Power Bus 216	0.00	0.00	0.00
Power Bus 217	0.00	0.00	0.00
Power Bus 218	0.00	0.00	0.00
Power Bus 219	0.00	0.00	0.00
Power Bus 220	0.00	0.00	0.00
Power Bus 221	0.00	0.00	0.00
Power Bus 222	0.00	0.00	0.00
Power Bus 223	0.00	0.00	0.00
Power Bus 224	0.00	0.00	0.00
Power Bus 225	0.00	0.00	0.00
Power Bus 226	0.00	0.00	0.00
Power Bus 227	0.00	0.00	0.00
Power Bus 228	0.00	0.00	0.00
Power Bus 229	0.00	0.00	0.00
Power Bus 230	0.00	0.00	0.00
Power Bus 231	0.00	0.00	0.00
Power Bus 232	0.00	0.00	0.00
Power Bus 233	0.00	0.00	0.00
Power Bus 234	0.00	0.00	0.00
Power Bus 235	0.00	0.00	0.00
Power Bus 236	0.00	0.00	0.00
Power Bus 237	0.00	0.00	0.00
Power Bus 238	0.00	0.00	0.00
Power Bus 239	0.00	0.00	0.00
Power Bus 240	0.00	0.00	0.00
Power Bus 241	0.00	0.00	0.00
Power Bus 242	0.00	0.00	0.00
Power Bus 243	0.00	0.00	0.00
Power Bus 244	0.00	0.00	0.00
Power Bus 245	0.00	0.00	0.00
Power Bus 246	0.00	0.00	0.00
Power Bus 247	0.00	0.00	0.00
Power Bus 248	0.00	0.00	0.00
Power Bus 249	0.00	0.00	0.00
Power Bus 250	0.00	0.00	0.00
Power Bus 251	0.00	0.00	0.00
Power Bus 252	0.00	0.00	0.00
Power Bus 253	0.00	0.00	0.00
Power Bus 254	0.00	0.00	0.00
Power Bus 255	0.00	0.00	0.00
Power Bus 256	0.00	0.00	0.00
Power Bus 257	0.00	0.00	0.00
Power Bus 258	0.00	0.00	0.00
Power Bus 259	0.00	0.00	0.00
Power Bus 260	0.00	0.00	0.00
Power Bus 261	0.00	0.00	0.00
Power Bus 262	0.00	0.00	0.00
Power Bus 263	0.00	0.00	0.00
Power Bus 264	0.00	0.00	0.00
Power Bus 265	0.00	0.00	0.00
Power Bus 266	0.00	0.00	0.00
Power Bus 267	0.00	0.00	0.00
Power Bus 268	0.00	0.00	0.00
Power Bus 269	0.00	0	

Problem:

- Cooling systems are insufficient to meet mobility requirements of future combat vehicles.
- Vehicular space claims limit additional heat rejection ability
- Increased demands for electrical power significantly impacts vehicle's cooling system sizes and weights
- Thermal degradation has direct impact on component life and reliability.
- Lack of intelligent control strategies for power system adds to thermal burden.
- Insufficient data exists on the efficiency benefits of emerging technologies applied to vehicle power electronics
-

Research Challenges:

- Intelligent thermal (heating/cooling) management system have not yet been explored
- Develop technology that requires less volume and greater heat rejecting capacity than current technology



Unclassified